

0.36, or 0.56 below normal; the greatest monthly amount, 1.11, occurred at Flandreau, and the least, trace, at Alexandria, Mellette, and Watertown.—*S. W. Glenn.*

Tennessee.—The mean temperature was 30.2°, or about 10.0° below normal; the highest was 76°, at Madison on the 20th, and the lowest, 30° below zero, at Erasmus on the 13th. The average precipitation was 5.83, or about 0.75 above normal; the greatest monthly amount, 14.15, occurred at Oakhill, and the least, 2.70, at Union City.—*H. C. Bate.*

Texas.—The mean temperature was 11.1° below normal; there was a general deficiency, ranging from 8° to 15°, with the greatest in the interior; the highest was 99°, at Fort Ringgold on the 3d, and the lowest, 23° below zero, at Tulia on the 12th. The average precipitation, determined by comparison of 50 stations, distributed throughout the State, was 1.10 below the normal. There was only a slight deficiency over the east coast district and the extreme western portion of west Texas, while the deficit was general in other sections and amounted to more than 1 inch in most places, with the greatest, 2.61, at Longview. The greatest monthly amount, 3.58, occurred at Brazoria, while none fell at several stations in the western portion. The month was very unfavorable for farming operations. The severe cold spell at the opening of the second decade stopped farm work in all sections. Drought is becoming very severe in places over west and north portions, placing farmers considerably behind with their work, especially plowing and making preparations for spring crops.—*I. M. Cline.*

Utah.—The mean temperature was 28.8°; the highest was 77°, at St. George on the 19th, and the lowest, 50° below zero, at Woodruff on the 6th. The average precipitation was 1.73; the greatest monthly amount,

5.85, occurred at Heber, and the least, trace, at Giles and St. George.—*L. H. Murdoch.*

Virginia.—The mean temperature was 30.2°, or 8.1° below normal; the highest was 80°, at Westpoint on the 4th, and the lowest, 29° below zero, at Monterey on the 10th. The average precipitation was 5.50, or 1.99 above normal; the greatest monthly amount, 8.18, occurred at Hampton, and the least, 2.65, at Monterey. The heavy fall of snow which attended the cold period of 10–16th afforded protection to winter crops and no winter killing has been reported.—*E. A. Evans.*

Washington.—The mean temperature was 32.5°, or 4.0° below normal; the highest was 63°, at Centerville on the 14th, at Kennewick on the 17th and at Fort Simcoe on the 18th, and the lowest, 36° below zero, at Usk on the 4th. The average precipitation was 5.43, or 1.30 above normal; the greatest monthly amount, 20.98, occurred at Clearwater, and the least, 0.31, at Sunnyside.—*G. N. Salisbury.*

Wisconsin.—The mean temperature was 9.3°, or 7.5 below normal; the highest was 58°, at Butternut on the 21st, and the lowest, 50° below zero, at Easton on the 10th. The average precipitation was 0.95, or 0.09 above normal; the greatest monthly amount, 2.51, occurred at Dodgeville, and the least, trace, at Racine and Westbend.—*W. M. Wilson.*

Wyoming.—The mean temperature was 11.2°, or 11.2 below normal; the highest was 55°, at several stations on different dates, and the lowest was 51° below zero, at Lowell on the 4th and at Basin on the 5th. The average precipitation was 1.78, or 1.03 above normal; the greatest monthly amount, 5.90, occurred at Centennial, and the least, 0.13, at Alcova. As a whole, the month was one of the coldest and stormiest on record in Wyoming.—*W. S. Palmer.*

SPECIAL CONTRIBUTIONS.

SNOW TEMPERATURES.

By E. B. CALVERT and W. F. R. PHILLIPS.

The snowstorms of February 5–8 and 11–13, 1899, were, for both the depth of the snowfall and the subsequent cold weather, most unusual for the region in which Washington, D. C., is situated. Following these storms the writers made some thermometric observations of the temperature of the snow at different depths from the surface. From the practical value that such observations appear to possess, we think that the series made by us is suggestive and of sufficient importance to publish.

The observations were made in snow that fell on an open plat of sod covered ground on the north side of the Weather Bureau building. Two classes of observations were made. One in snow on which the sun had shone for some hours and the other in snow that had been shaded for some time by the building.

Snow began to fall on the morning of February 5 and continued at intervals till the morning of the 8th. At the end of the storm the snow was about 13 inches deep. At the beginning of the snow the temperature of the air was 32°, and it gradually fell to 25° at the end of the storm. The tem-

perature continued to fall till on the morning of the 11th it was 15° below zero, the lowest temperature ever recorded for Washington, D. C. The second storm began during the afternoon of the 11th and continued into the night of the 13th. The temperature of the air during this storm ranged from 15° below zero to 11° above. The snow was considerably drifted by the high winds that prevailed during its fall. On the morning of the 14th the snow measured from 25 to 30 inches deep in level places in front of the Weather Bureau building.

The first set of snow temperature observations was made on the afternoon of February 9 in snow 10 inches deep. At this time the atmospheric temperature was 8°. A thermometer lying immediately on the surface of the snow indicated, in the shade, a temperature of 3°, and, in the sun, a temperature of 9°. The results of the other readings made in the shade were as follows, viz: Three inches below the surface of the snow (or 7 inches from the surface of the ground) the temperature was 16°; 6 inches below the surface (4 inches from the ground) it was 20°; and 10 inches below the surface, the bulb of the thermometer touching the ground, the temperature was 31°.

On the following morning, with an air temperature of 6°

February, 1899.

Distance of thermometer bulb from surface of—		9th.		10th.				11th.				14th.			
		3 p. m.		10 a. m.		3 p. m.		10 a. m.		3 p. m.		10 a. m.		3 p. m.	
Snow.	Ground.	Shade.	Sun.	Shade.	Sun.	Shade.	Sun.	Shade.	Sun.	Shade.	Sun.	Shade.	Sun.	Shade.	Sun.
On surface	10 inches above..	8.0	9.0	— 7.5	— 7.5	— 8.0	5.5	8.0	15.5	11.0	14.0	8.0	.....	.....	.....
Just below	9–10 inches above .....	.....	.....	.....	— 5.5	— 4.0	3.5	1.0	14.5	9.5	15.5	8.0	.....	.....	.....
3 inches below ..	7 inches above	18.0	15.0	8.5	5.5	5.0	11.0	5.0	11.0	15.0	15.0	6.5	.....	.....	.....
6 inches below ..	4 inches above	20.0	20.0	14.0	15.0	15.0	16.5	16.0	20.0	18.5	20.0	9.5	.....	.....	.....
6 inches below ..	On ground .....	.....	31.5	.....	27.0	.....	28.0	.....	.....	.....	.....	.....	.....	.....	.....
9 inches below ..	1 inch above .....	.....	27.0	20.0	28.0	28.0	29.0	.....	.....	18.5	27.0	9.5	.....	.....	.....
10 inches below ..	On ground	31.0	31.0	31.0	29.5	31.5	30.0	27.0	22.0	31.0	29.0	.....	.....	.....	.....
23 inches below ..	On ground .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	30.5	.....	.....	31.5
19 inches below ..	6 inches above .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	25.0	.....	.....	24.5
16 inches below ..	9 inches above .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21.0	.....	.....	23.5
13 inches below ..	12 inches above .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18.0	.....	.....	18.0
7 inches below ..	18 inches above .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.0	.....	.....	11.5
On surface	25 inches above .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10.0	.....	.....	34.0
Temp. of air 65 feet above snow .....	.....	8.0	.....	— 6.0	.....	3.0	.....	— 1.0	.....	12.0	.....	13.0	.....	22.0	.....
Temp. of air 1 foot above snow .....	.....	8.0	.....	— 5.0	.....	2.0	.....	1.5	.....	11.0	.....	14.5	.....	.....	.....
Velocity of wind, in miles per hour ..	.....	22.0	.....	14.0	.....	12.0	.....	6.0	.....	4.0	.....	17.0	.....	11.0	.....

to 8° below zero, a thermometer on the surface of the snow, in the shade, indicated 7.5° below zero; at the same time one 6 inches below the surface read 14° above zero; and one 10 inches below the surface and touching the ground read 31°, the same as the evening before.

On the morning of the 11th, when the average temperature of the air had been 2° below zero for the preceding twenty-four hours, a temperature of 27° was registered by a thermometer 10 inches below the surface of the snow and in contact with the ground. This was the lowest temperature observed in the layer of snow immediately touching the soil.

Observations were made also in a spot of several square yards in extent from which the snow had been blown till it measured but 6 inches in depth. The temperature of the snow in contact with the ground was found to range from 31.5° to 27°. The snow in this place was exposed to the sun throughout the day.

On the 14th, observations were made in snow 25 inches deep, the depth of the snow having been greatly increased by the storm of the 11-13th. The results were the same as had been previously found so far as regards the temperature of the snow immediately on the surface of the ground.

It was noticed in all our observations that the temperature of the snow layer immediately touching the ground was fairly uniform, being on the average 31°. During the period covered by our observations the extreme range of temperature of the snow layer in contact with the ground was but 5°, while that of the atmosphere was 37°. The greatest difference observed between the atmospheric temperature and that of the snow near the ground was 38.5°, on the morning of the 10th, the temperature of the air being 7.5° below zero, and that of the snow layer touching the ground 31° above zero.

The observations made in snow upon which the sun had shone for some hours showed that the temperature of the superficial layer of the snow was considerably influenced by direct solar radiation.

The most striking fact developed in our observations was the relatively high and uniform temperature observed at the surface of the ground. This was due undoubtedly to the barrier to radiation interposed by the snow mantle. From the 5th to 14th, inclusive, the average temperature of the air was 13°, and the average temperature of the snow covered soil was certainly not below 31°. In other words, notwithstanding the fact that the temperature of the air was for 240 hours 18° lower than that of the soil, yet the latter apparently lost none of its heat. That the surface soil actually lost heat there can be no doubt, but the loss was gradual and no more rapid than the rate of conduction upward from the warmer underlying layers of earth.

The practical benefits resulting from these two snow storms, storms in which few perhaps saw any good, may now be mentioned. Had the severe cold that came with and stayed after the snows occurred without snow, or without a snow covered ground, the temperature of the soil would have fallen many degrees below freezing, and the damage to vegetation resulting from the freezing of the roots would have been enormous. But wherever the ground was covered by snow no such damage was done.

The observations are shown in detail in the table.

OBSERVATIONS AT HONOLULU.

Through the kind cooperation of Mr. Curtis J. Lyons, Meteorologist to the Government Survey, the monthly report of meteorological conditions at Honolulu is now made nearly in accordance with the new form, No. 1040, and the arrange-

ment of the columns, therefore, differs from those previously published.

Meteorological observations at Honolulu.

FEBRUARY, 1899.

The station is at 21° 18' N., 157° 50' W.; altitude 50 feet. Pressure is corrected for temperature and reduced to sea level, and the gravity correction, -0.06, has been applied.

The average direction and maximum force of the wind and the average cloudiness for the whole day are given unless they have varied more than usual, in which case the extremes are given. The scale of wind force is 0 to 12, or Beaufort scale. Two directions of wind, or values of wind force, connected by a dash, indicate change from one to the other.

The rainfall for twenty-four hours is now given as measured at 1 p. m. Greenwich time on the respective dates.

The rain gauge, 8 inches in diameter, is 1 foot above ground. Thermometer, 9 feet above ground. Ground is 50 feet above sea level.

Date.	Pressure at sea level.	Temperature.		During twenty-four hours preceding 1 p. m., Greenwich time, or 2:30 a. m., Honolulu time, of the respective dates.									
		Dry bulb.	Wet bulb.	Temperature.		Means.		Wind.		Total rainfall.	Average cloudiness.	Sea-level pressures.	
				Maximum.	Minimum.	Dew point.	Relative humidity.	Prevailing direction.	Maximum force.			Maximum.	Minimum.
1.....	29.83	64	68.5	78	62	63.3	73	nne.	3	0.00	5-2	29.99	29.88
2.....	29.78	63	63	78	62	64.5	82	nne-w.	1	0.00	3-6	29.85	29.74
3.....	29.82	64	63	77	62	64.5	84	sw.	1	0.02	3-6	29.85	29.76
4.....	29.82	66	64	78	62	63.5	81	sw-w.	1	0.00	1-3	29.88	29.78
5.....	29.85	69	66.5	79	63	65.5	79	sw-w.	2	0.00	2-7	29.88	29.82
6.....	29.92	70	69	79	68	66.3	78	sw.	3-1	0.01	5-2	29.93	29.86
7.....	29.91	69	67	80	69	69.0	86	sw.	2-1	2.33	8-10	29.97	29.90
8.....	29.94	68	67	73	68	67.5	92	sw-w.	2-0	1.07	10	29.98	29.91
9.....	29.99	67	66.5	78	67	68.5	87	sw.	2-0	0.00	3-8	29.99	29.92
10.....	30.06	64	63	78	67	67.7	90	sw-s.	1-0	0.02	2	30.06	30.00
11.....	30.04	63	62.5	80	63	64.0	69	s-e.	1	0.00	1	30.10	30.00
12.....	30.00	64	63	81	62	64.7	80	se-ne.	2-0	0.00	1-3	30.08	29.99
13.....	30.01	69	64	79	63	64.0	81	sw-nw.	2	0.01	3-7	30.04	29.97
14.....	30.00	68	64	78	63	63.7	71	ne-s.	2-0	0.00	5	30.07	29.98
15.....	30.03	67	65	80	67	64.0	74	sw.	1	0.00	5	30.07	30.01
16.....	30.01	69	67.5	80	64	66.0	81	s.	1	0.06	5	30.09	30.00
17.....	30.01	65	64	80	65	67.5	84	ne-sw.	1-0	0.00	6-1	30.06	29.97
18.....	30.00	72	64	79	64	68.5	78	s-ne.	1	0.00	5	30.04	29.96
19.....	29.97	73	67	78	71	69.7	64	ne.	3	0.05	6	30.03	29.96
20.....	29.99	73	65	79	70	68.0	68	ne.	3-0	0.00	4	30.04	29.96
21.....	29.99	72	65.5	80	66	63.0	66	ne.	2	0.01	3-6	30.08	29.96
22.....	29.97	71	64.5	78	71	61.7	67	ne.	3-4	0.03	4	30.03	29.95
23.....	29.94	71	65	77	69	63.0	68	ne.	3-4	0.08	2-6	30.00	29.90
24.....	29.95	71	66	78	69	63.3	73	ne.	4	0.04	5-8	29.99	29.91
25.....	30.01	72	67	80	68	64.0	70	ne.	3-0	0.09	7	30.01	29.96
26.....	30.07	72	66	79	68	64.5	70	ne.	3-5	0.01	5	30.09	30.01
27.....	30.05	69	66	78	71	61.5	64	ne.	4-6	0.15	8	30.10	30.01
28.....	30.05	71	65	77	68	63.8	76	ne.	5-6	0.03	9-6	30.10	30.01
Sums..	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.01	.....	.....	.....
Means.	29.961	68.4	65.0	77.0	66.1	64.4	76.3	.....	1	.....	7	30.012	29.981
Departure..	-0.01	.....	.....	.....	.....	+2.2	+0.3	.....	.....	-1.00	.....	.....	.....

Mean temperature for February, 1899 (6+2+9)+3=71.9°; normal is 70.3°. Mean pressure for February is 29.96; normal is 29.97.

* This pressure is as recorded at 1 p. m., Greenwich time. † These temperatures are observed at 6 a. m., local, or 4:30 p. m., Greenwich time. ‡ These values are the means of (6+9+2+9)+4. § Beaufort scale. ¶ Mean for the daytime is 1.0. ¶ The mean during daylight is 4.4.

RECENT PAPERS BEARING ON METEOROLOGY.

W. F. R. PHILLIPS, in charge of Library, etc.

The subjoined list of titles has been selected from the contents of the periodicals and serials recently received in the library of the Weather Bureau. The titles selected are of papers or other communications bearing on meteorology or cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled; it shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau:

- Annales Agronomiques, Paris, Tome 25.*
Pagnoul. Influence des pluies et de la nature des terres sur le rendement des fourrages. P. 83.
Scottish Geographical Magazine, Edinburgh, Vol. 15.
Taylor, W. A. Meteorology of Mount Etna. [Abstract from Ciel et Terre.] P. 147.
Nature, London, Vol. 59.
Arcimis, A. Probable Weather Conditions in Spain, during the Total Solar Eclipse of May 28, 1900. P. 439.
MacDowall, A. B. American and English Winters. P. 416.